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EXPERIMENTAL DEFORMATION OF SALT IN CYCLIC LOADING

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Abstract

Compressed air energy storage in geologic media has been proposed to help "firm" renewable energy sources, for example wind and solar, by providing a means to store energy when excess energy was available, and to provide an energy source during non productive renewable energy time periods. Such a storage media may experience hourly (perhaps small) pressure swings within a geologic storage media. This implies that the storage "container", for example, a salt cavern, may experience small irregular pressure cycling.

An initial study has been undertaken wherein room temperature confined rock salt specimens (a Gulf Coast domal salt 99% halite) have been cyclically stressed. The rock salt was first characterized by developing a dilatancy "strength" criterion. Then, samples confined at 3000 psi were cycled (in triaxial compression) between 25-30% and 50-60% of the dilatant strength. Samples were cycled up to the 50-60% load, held at constant stress for ~ 3 hours, then cycled down to the 25-30% load, and then again held for ~3 hours. Samples experienced about four load cycles per day; tests ran from 12 days to about 60 days, resulting in about 40 to 240 load cycles on different samples.

During tests, axial and radial displacements were recorded. For all tests, it was found that Young's Modulus determined from unloading cycles decreased with increasing axial strain, load cycle, and time after an initial period of small change wherein the modulus remained the same or increased. Using a dilatancy criterion of the volume strain changing from compaction to dilation, the samples are also observed to appear to dilate at these low stress levels. These strain measurements, from this limited study, imply that the samples were cracking at these low cyclically-applied differential stresses below the dilation criterion curve. The recording of acoustic emissions during testing and presence of microfractures using rhodemine dyed epoxy impregnation in deformed samples confirmed the source of the dilatant behavior.

Key words: Cyclic loading, Rock salt, Renewable Energy**,** Rock Mechanics, Semi-brittle